REMARKS

In the final Office Action mailed February 21, 2003, claim 17 was objected to and claims 1, 3,7, 13-15, 17, and 18 were rejected under 35 USC §103(a) as being unpatentable over Tanaka et al. (U.S. Patent No. 5,542,064) in view of Joho (U.S. Patent No. 5,408,634). The foregoing objections and rejections are respectfully traversed.

Claims 1, 7, 13, 14, 15, 17, and 18 are amended. New claims 19 and 20 are added.

A Version with Markings to Show Changes Made to the claims is enclosed herewith.

No new matter is presented.

Claims 1, 3, 7, 13-15, 17, 18, 19 and 20 are pending, of which claims 1, 7, 13-15, 19 and 20 are independent. Claim 3 depends from claim 1; claim 17 depends from claim 1; and claim 18 depends from claim 7.

Objections to claim 17

Claim 17 is amended, taking the Examiner's comments into consideration. Withdrawal of the objections to claim 17 is respectfully requested.

References relied upon in the Office Action: Tanaka and Joho

Tanaka discloses that the object is to enhance the input/output throughput of a secondary storage device having a plurality of storage units as disclosed in column 2, lines 25-30, and the attaining method is to select storage units less in the degree of waiting for processing of input/output commands as a group of storage units to be subjected to multiple writing of identical data in a secondary storage device having a plurality of storage units, as described in column 2, lines 54-60.

But, the selecting step and accessing step of Tanaka are different from that of the present invention. These steps of Tanaka are disclosed in column 7, lines 65 to column 8, and lines, and in Fig. 7 in Tanaka.

In step S605 and S610 of Tanaka, idle disk drives having the requested data are selected, and in steps S620 and S625, plural disk drives having the objective data are selected

unless the number of the selected disk drives reaches the threshold 1 (see column 8, lines 31-37). Moreover, in S630, a number of output commands are generated correspondingly to the number of the selected disk drives, and in S635-645, "when a report of achieving a connection to one of the disk drives 16-1 to 16-n receiving output commands output commands of disk drives except the first connected disk drive are cancelled."

That is, the selecting and accessing steps in Tanaka discuss selecting less waiting disk drives, not a minimum waiting single disk drive as in the present invention, and to output the commands to the less waiting plural disk drives and connect first connected single disk drive, not output commands to the single minimum waiting disk drive as in the present invention.

The Tanaka apparatus compares whether a queue is larger than a threshold (refer to col. 7 at lines 37-40, and step 505 of Figure 6 of Tanaka), whereas the present invention compares the numbers of operations of physical disk units with each other.

On page 4 of the February 21 Office Action, the Examiner re-states that Tanaka does not disclose sending of the request to only the single minimum waiting disk unit, but the design philosophy of Tanaka is to allow a selection of the lowest waiting disk units, and an artisan would have recognized that if there is a single minimum waiting time, this unit should be the one selected since Joho teaches this concept in analogous multiple disk systems.

Joho discloses a multiple disk system that queues a new access only in the disk unit having the minimum waiting time. Joho does not disclose a multiple disk system that queues a new access only in the disk unit having the minimum waiting operation number, as in the present invention.

In contrast to the foregoing references relied upon, each of independent claims 1, 7, and 13-15 to recites (using the recitation of claim 1 as an example):

wherein said control means "compares numbers of operations corresponding to a plurality of physical disk units which store said designated logical volume with each other, selects the single physical disk unit from among the disk units storing the designated logical volume which has a minim number of operations based on the comparison, and outputs a request to only the selected single minimum waiting physical disk unit having the minimum number of operations based on the comparison".

In addition, the foregoing dependent claims recite patentably distinguishing features of their own. For example, claim 3/1 recites that the control means includes "a channel adapter

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circuit performing interface control with said high-rank apparatus", "a device adapter circuit accessing said physical disk units in accordance with a requested operation", and "a resource manager circuit determining one of the plurality of physical disk units to be accessed in accordance with said number of operations in said memory in response to a transfer request from said channel adapter circuit, and requesting said device adapter circuit to perform an operation accessing said determined physical disk unit".

Withdrawal of the foregoing rejections of claims 1, 3, 7, 13-15, 17, and 18 is respectfully requested.

References cited in the February 4 Information Disclosure Statement

The Information Disclosure Statement filed February 4, 2003 cited a first Office Action issued in a counterpart Japanese patent application and the two prior art references cited therein (both by Fujitsu Limited, the assignee of the subject application): JP 60-205641 and JP 3-253933. The Examiner has returned to us the Form PTO-1449 (initialed and signed by the Examiner as having considered same) which accompanied the February 4 Information Disclosure Statement.

Attorney for applicants is advised that one of the cited references (JP 60-205641 by Fujitsu) discloses a volume accessing method for accessing one physical volume among a plurality of physical volume storing logical volume and having a pair of counters for counting the request number of each physical disk and for queuing a new access in minimum counting number disk.

Attorney for applicant is further advised that the other of the cited references (JP 3-253933 by Fujitsu) discloses a multiple disk system for alternately accessing plural disk and having table indicating abnormal disk number.

Each of independent claims 1, 7, and 13-15 of the present application recites (using the recitation of claim 1 as an example) "judges whether or not status information of the logical volume indicates abnormal" and "selects said single physical disk unit...by said comparison of the operation numbers when a plurality of disk units...are normal from said status information".

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New Independent claims 19 and 20

Moreover, new independent claim 19 recites "a memory having a logical volume structure table storing a status of said plurality of physical disk units of each logical volume, and a disk management table storing statuses and the number of operations of each physical disk unit" and "a control unit which refers to said logical volume structure table with said designated logical volume, judges whether or not said status information of logical volume indicates abnormal and selects said single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume and selects a normal physical disk unit among said plurality of physical disk units indicates by the status information of said logical disk units when said status information indicates abnormal".

New independent claim 20 recites "referring to a memory storing a table indicating a plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volume and status information indicating statuses and the operation numbers of said physical disk units", "judging whether or not said status information of logical volume indicates abnormal", "selecting a single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume", and "selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information indicates abnormal".

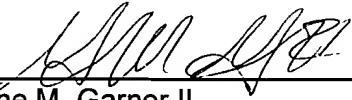Allowance of new claims 19 and 20 over the foregoing references is respectfully requested.

If there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please AMEND the following claims:

1. (NINE TIMES AMENDED) A RAID apparatus comprising:

a plurality of physical disk units storing a plurality of copies of each of logical volumes; and

a disk controller accessing any of the physical disk units which stores a designated logical volume to thereby access said designated logical volume,

said disk controller including:

a memory storing the number of operations requested to each physical disk unit, for each physical disk unit, and

control means for accessing one of said plurality of physical disk units which stores the designated logical volume, in accordance with said number of operations,

wherein said control means compares numbers of operations corresponding to a plurality of physical disk units which store said designated logical volume with each other, selects the single physical disk unit from among the disk units storing the designated logical volume which has a minimum number of operations based on the comparison, and outputs a request to only the selected single minimum waiting physical disk unit having the minimum number of operations based on the comparison,

wherein said control means increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said physical disk units performs requested operations in a queued order, and

wherein said memory stores a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volume and status information indicating statuses of said physical disk units; and said control means refers to said memory with said designated logical volume, judges whether or not said status information of logical volume indicates abnormal and selects said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are

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normal from said status information of said logical volume and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information indicates abnormal.

7. (EIGHT TIMES AMENDED) An access control method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, and a disk controller accessing any physical disk unit which stores a designated logical volume to thereby access said designated logical volume, said method comprising:

determining a plurality of physical disk units which store a designated logical volume; and

selecting from among the determined disk units storing the designated logical volume one of said determined physical disk units in accordance with the number of operations requested to said physical disk units, said selecting comprising:

comparing said numbers of operations of a plurality of physical disk units which store said designated logical volumes with each other,

accessing the single physical disk unit which has a minimum number of operations based on the comparison and outputting a request to only said selected [single minimum] waiting physical disk unit having the minimum number of operations based on the comparison,

incrementing the number of operations of said accessed physical disk unit in accordance with a request for said operation, and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said plurality of physical disk units performs requested operations in a queued order, and

wherein said selecting further comprises referring to a memory storing a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volume and status information indicating statuses of said physical disk units, judging whether or not said status information of logical volume indicates abnormal, and

selecting said physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume and [selects] selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information

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indicates abnormal.

13. (EIGHT TIMES AMENDED) A RAID apparatus comprising:

physical disk units storing redundant logical volumes, a first of the redundant logical volumes being stored on one of the physical disk units, and a second of the redundant logical volumes being stored on another of the physical disk units; and

a disk controller counting numbers of operations respectively requested of each of the physical disk units and accessing one of the first and the second of the redundant logical volumes based on a minimum number of the numbers of operation respectively requested of each of the physical disk units storing the redundant logical volumes based on the counting, and outputting a request to only the accessed single [minimum waiting] physical disk unit having the minimum number of operations based on the comparison,

wherein said disk controller increments the number of operations of an accessed physical disk unit in accordance with a request for said operation and decrements the number of operations of an accessed physical disk unit whose operation has been completed, in accordance with an end of said operation,

wherein each of said physical disk units performs requested operations in a queued order, and

wherein said disk controller refers to a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each said redundant logical volumes and status information indicating statuses of said physical disk units; judges whether or not said status information of logical volume indicates abnormal; selects said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of the logical volume and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information indicates abnormal.

14. (SEVEN TIMES AMENDED) A RAID controller accessing one of a plurality of physical disk units storing a plurality of copies of each of logical volumes to thereby access a designated logical volume, comprising:

a memory storing a number of operations requested of each physical disk unit

corresponding to each physical disk unit; and

a controller comparing said numbers of operations corresponding to a plurality of physical disk units which store a designated logical volume with each other, and selecting single one of said plurality of physical disk units which has a minimum number of operations from among the plurality of physical disk units storing the designated logical volume based on the comparison and outputting a request to only said selected single [minimum waiting] physical disk unit having the minimum number of operations based on the comparison,

wherein said controller increments the number of operations of said selected physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said plurality of physical disk units performs requested operations in a queued order, and

wherein said memory stores a table indicating [a correspondence of the] a plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volume and status information indicating statuses of said physical disk units; and said designated logical volume; judges whether or not said status information of logical volume indicates abnormal and said status information of logical volume indicates abnormal [and said controller refers to said memory with said designated logical volume to select] selects said single [a] physical disk unit on which said designated logical volume is allocated by said comparison of the operation umbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of the logical volume and selects a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information indicates abnormal [in accordance with said designation of said designated logical volume by a high-rank apparatus].

15. (SEVEN TIMES AMENDED) A balancing access method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, comprising:

comparing numbers of operations of a plurality of physical disk units which store a designated logical volume with each other;

selecting a single one of said physical disk units which has a minimum number of operations from the disk units storing the designated logical volume based on the comparison

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and outputting a request to only said selected single minimum waiting physical disk unit;

incrementing the number of operations of said accessed physical disk unit in accordance with a request on said operation; and

decrementing the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation, wherein each of said physical disk units performs requested operations in a queued order, and

wherein said selecting further comprises referring to a memory storing a table indicating the plurality of physical disk units and a status information of said logical volume corresponding to each of said logical volume and status information indicating statuses of said physical disk units; judging whether or not said status information of logical volume indicates abnormal, and selecting said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume and [selects] selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said disk unit among said plurality of physical disk units when said status information indicates abnormal.

17.   (ONCE AMENDED) The RAID apparatus according to claim 1, wherein said table in the memory comprising:

a logical volume structure table storing statuses and said plurality of physical disk units of each logical volume; and

a disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said control means refers to said logical volume structure table with said designated logical volume, and selects said single physical disk unit on which said designated logical volume is allocated [bys aid] by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table and selects a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

18.   (ONCE AMENDED) The access control method according to claim 7, wherein

said referring comprises referring said memory comprising a logical volume structure table storing [statuses] status of and said plurality of physical disk units of each logical volume and disk management table storing statuses and the number of operations of each physical disk unit,

and wherein said selecting comprising: selecting said single physical disk unit on which said designated logical volume is allocated by said comparison of the operation numbers in the disk management table when determining that a plurality of physical disk units storing copies of said designated logical volume are normal from said logical volume structure table; and selecting a normal physical disk unit among said plurality of physical disk units from said disk management table when said status of said designated logical volume indicates abnormal.

Please ADD new claims 19 and 20.

--19. (NEW) A RAID apparatus comprising:

a plurality of physical disk units storing a plurality of copies of each of logical volumes; and

a disk controller accessing any of the physical disk units which stores a designated logical volume to thereby access said designated logical volume,

said disk controller including:

a memory having a logical volume structure table storing a status of said plurality of physical disk units of each logical volume, and a disk management table storing statuses and the number of operations of each physical disk unit; and

a control unit which refers to said logical volume structure table with said designated logical volume, judges whether or not said status information of logical volume indicates abnormal and selects said single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume and selects a normal physical disk unit among said plurality of physical disk units indicates by the status information of said logical disk units when said status information indicates abnormal.

20.   (NEW) A RAID access method for a RAID apparatus comprising a plurality of physical disk units storing a plurality of copies of each of logical volumes, comprising:

referring to a memory storing a table indicating a plurality of physical disk units and a

status information of said logical volume corresponding to each of said logical volume and status information indicating statuses and the operation numbers of said physical disk units;

judging whether or not said status information of logical volume indicates abnormal;

selecting a single physical disk unit on which said designated logical volume is allocated by comparison of the operation numbers when a plurality of physical disk units storing copies of said designated logical volume are normal from said status information of said logical volume; and

selecting a normal physical disk unit among said plurality of physical disk units indicated by the status information of said logical disk units when said status information indicates abnormal.--